Integrated Erasure-based Coding for Reliable Multicast Retransmission

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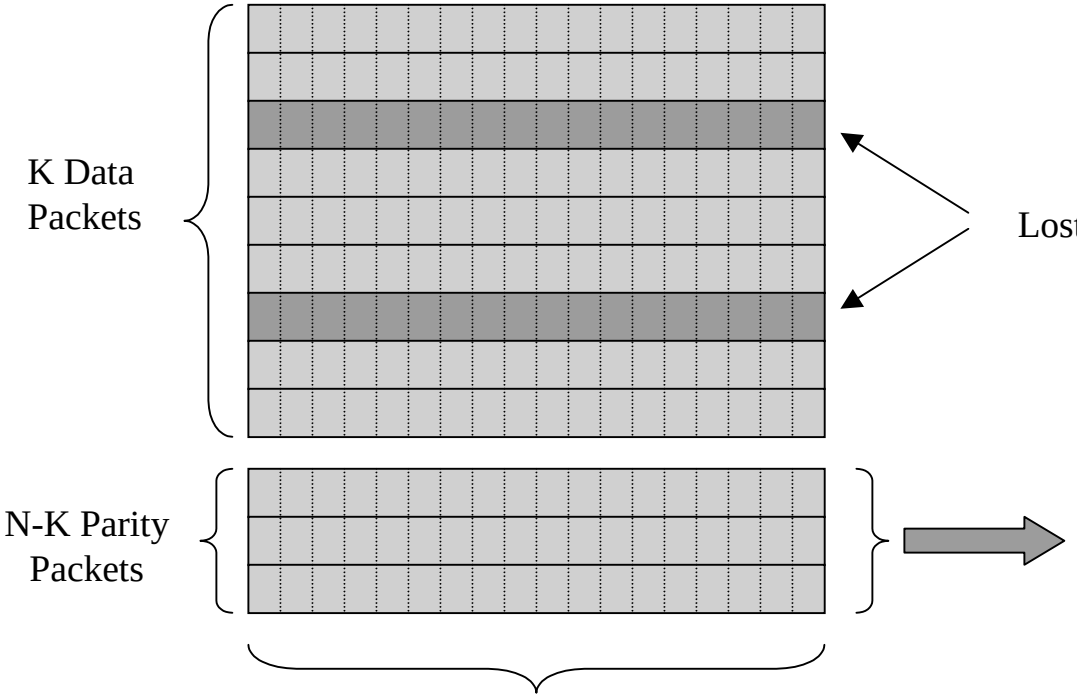
Some Background



Erasure-based Correction Methods

1) Send parity with DATA
Fixed or Variable code rate

2) Request Parity Retransmission
Send 0 parity on 1st block cycle

3) Hybrid
Send some parity with data block,
request more when conditions worsen

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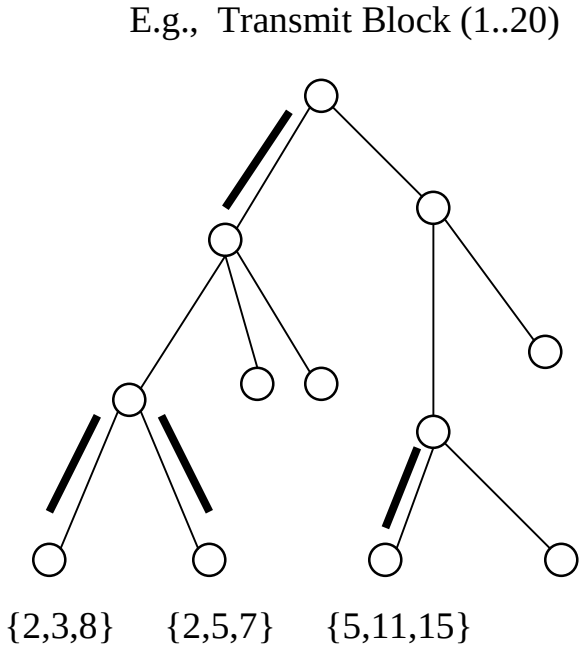
Integrated Retransmission

- Don’t transmit any parity on 1st cycle
- Modify RM Nack Process
  - report only max lost among receiver group {block id, max lost}
  - can still do repair backoff
  - no parsing nacked sequence numbers,block bit maps,etc
- Scaled groups can show large % loss in total
  - single retransmitted parity can repair multiple lost packets
  - significant RM message reduction for uncorrelated loss cases
  - with an integrated retransmission approach you do not have preestimate the amount of parity needed

Performance Gain for Uncorrelated Loss



Total Lost Packets = 6
Max Lost Per Receiver = 3

- Single parity packet can repair multiple packets across receiver set
- We can integrate this into Nack processing to improve scaling when uncorrelated loss is anticipated
- Can use this for streaming but there is:
  - delay penalty
  - processing penalty
- Makes a lot of sense for bulk transfer to large groups in one-to-many environments

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Simple Loss Model Example

1. uncorrelated packet loss
2. Homogeneous loss probability
3. N= packet block size, M= receiver group size

Expected Value of 2nd Cycle Repair Retransmissons?

$$\mathrm{NoFEC}(n, m, p) := n \cdot \left[1 - (1 - p)^{m} \right]$$

With parity erasure-based repairing
here's the pdf of the max among nodes

$$\mathrm{pdfFEC}(n, m, p, k) := \sum_{j=1}^{m} \frac{m!}{(j!) \cdot (m - j)!} \cdot \mathrm{dbinom}(k, n, p)^{j} \cdot \mathrm{pbinom}(k - 1, n, p)^{m - j}$$

$$\mathrm{FEC}(n, m, p) := \sum_{i=1}^{n} i \cdot \mathrm{pdfFEC}(n, m, p, i)$$

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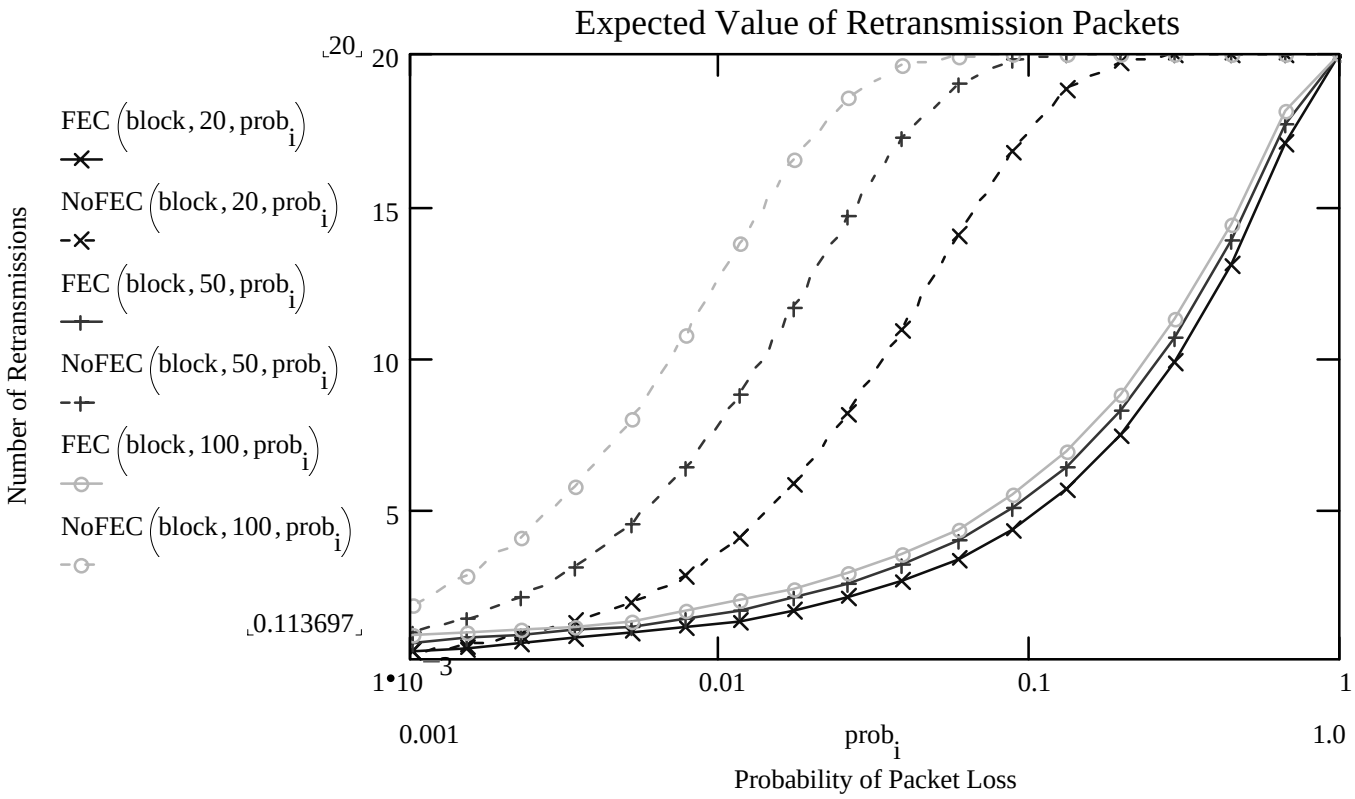
Example Message Reduction



Block=20 packets, Group Sizes of 20,50,100

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